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Estimation of thiamine, riboflavin and niacin content in jute leaves

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Abstract

Thiamine, riboflavin and niacin are essential nutrients and play vital role in oxidation-reduction reaction during energy production in the living cell of the body. Requirement of these vitamins must be met through diet as human body cannot synthesize thiamine and riboflavin. Small amount of niacin is synthesized in the body but major requirement must be met through external diet. Jute leaves are rich in different vitamins and minerals. Different varieties of fresh jute leaves as well as preserved leaves of *Corchorus olitorius*. L. and *Corchorus capsularis* L. were evaluated for thiamine, riboflavin and niacin content. Powder jute leaf were prepared through drying of leaves in cold (4˚C), oven (100˚C) and open air (±30˚C) and then ground following preservation at -20˚C in freezer. Thiamine content in fresh leaves of *C. olitorius* is 3.22 – 5.84 mg/g and in *C. capsularis* is 4.26 – 6.46 mg/g. Jute leaves in both species show riboflavin content 1.00 – 1.35 mg/g. Niacin was found in leaves of *C. olitorius* 12.01 – 19.12 mg/g and in *C. capsularis* 12.95 – 23.17 mg/g in different varieties. Preserved leaf powder of *C. olitorius* and *C. capsularis* contain 0.37 – 0.58 mg/g thiamine. High amount of riboflavin was found in jute leaf powder of both species. Preserved leaf powder of *C. olitorius* shows 4.24 – 13.42 mg/g riboflavin and *C. capsularis* have 9.14 to 19.59 mg/g. Niacin content was found stable in preserved jute leaf powder. Preserved powder leaf of *C. olitorius* contain 8.4 - 14.8 mg/g niacin and leaves of *C. capsularis* have 5.8– 8.3 mg/g of niacin. There is no significant difference observed in leaves of different varieties of *C. olitorius* and *C. capsularis* regarding thiamine, riboflavin and niacin content. Drying showed different effect on vitamins in jute leaves, it reduced thiamine content, increased riboflavin content but did not affect much on niacin content in jute leaves in comparison to the fresh leaves. Different drying method did not show significant difference in thiamine, riboflavin and niacin content in jute leaves. Fresh jute leaves and preserved jute leaf powder both contain thiamine, riboflavin and niacin.

Keywords: Thiamine; Riboflavin; Niacin; Jute leaves*; Corchorus olitorius; Corchorus capsularis*

1. Introduction

Jute leaves are rich in antioxidants and vitamins especially E, A and C. These three vitamins are powerful antioxidants that help to protect cell damage from free radicals. The role of vitamin A, C, E and B-complex have been understood for their anti-oxidative and anti-carcinogenic properties [1, 2]. Jute leaves have been investigated earlier for vitamin A, vitamin C [3-10] and vitamin B including B1, B2, B3, B6 etc. [11- 13]. Thiamine, riboflavin and niacin are water soluble vitamins and known as vitamin B1, B2 and B3 respectively. Water soluble vitamins are crucial for maintaining good health in humans; lack of a sufficient amount of any of them can cause serious diseases [14]. These are considered as essential nutrients. Thiamine is required to form adenosine triphosphate (ATP), which every cell of the body uses for

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energy [15]. Riboflavin is the precursor of the enzyme cofactor flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD), Vitamin B2 can be found in nature as free riboflavin, but in most of the biological material, it occurs predominantly in the form of two coenzymes, flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD) [16]. Niacin performs important metabolic roles in living cells as a precursor of NAD+/NADH and NADP+/NADPH [17]. As such, over 200 enzymes use niacin in the coenzyme form in plant and animal cells for reactions involving electron transfer, energy production and degradation of carbohydrates, proteins, fats and alcohol [18]. Thiamine, Riboflavin and Niacin act individual as a co-enzymes for oxidation-reduction reaction in the body. Thiamine acts as a co-enzymes for oxidation-reduction in the body, specially glucose metabolism, the pentose shunt and the citric acid cycle [19, 20]. Riboflavin is the precursor of the enzyme cofactor flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD), which are the vital in body's many of the enzymatic functions for the transfer of electrons in oxidation-reduction reaction. Niacin metabolized through different pathways and transformed into other form [21]. These metabolized are involved in critical reactions in the body such as cellular oxidation-reduction reactions, DNA repair, calcium mobilization, and deacetylation, [21, 22].

Thiamine deficiency causes beriberi and can be fatal if it remains untreated. Riboflavin deficiency cause various nonspecific skin and mucosal lesions, normochromic-normocytic anemia etc. Riboflavin deficiency usually occurs with other B vitamin deficiencies. Niacin deficiency causes the disease called as "pellagra". In man which is characterized by the rough or raw skin. Niacin deficiency is also associated with an increased risk of cancer [23].

Thiamine, riboflavin and niacin are used individually or as B complex for the treatment and therapeutic purpose. Thiamine is used for treatment of many disorders and diseases [24]. Riboflavin has been found to be effective in the treatment of malaria [14], migraine [25] and Parkinson's disease [16]. Niacin (NA) is known as a lipid lowering drug for decades. It has also been used therapeutically for blood cholesterol control [26, 27, 28]. Clinical studies have shown that nicotinic acid therapy reduces the number of cardiac and fatal heart diseases [24, 29]. Thiamine [30], riboflavin [31] and niacin [32] have antioxidant properties. Thiamine and riboflavin cannot be synthesized by animals or human and must obtain by their diet. A small amount of the niacin can be synthesized from the daily dietary amino acid tryptophan, but most of the daily requirement must be met by external sources of niacin [33].

Thiamine is present in small quantities in several food groups: wheat, rice, yeast, beef, pork, poultry, fish, milk, green leafy vegetables, nuts and seeds [25, 34]. Riboflavin is commonly obtained from meat, eggs, fortified cereals and green leafy vegetables, in addition to dairy products, which contribute most significantly to riboflavin intake [35]. Good sources of niacin include yeast, meat, poultry, red fish (e.g., tuna, salmon), cereals, legumes and seeds. Milk, green leafy vegetables, coffee and tea also provide some niacin [36]. Green leafy vegetables are one of the sources of thiamine, riboflavin and niacin. Jute leaves were investigated before for vitamin B1, B2 and B3 by several researchers but presence of the three were mentioned in food composition table [13] and Adeniyi and his Colleague [37]. Other reports varied regarding presence of these vitamins [11, 12]. This research has been conducted to know i) the status of thiamine (vitamin B1), riboflavin (vitamin B2) and niacin (vitamin B3) content in jute leaves of some commercial varieties and ii) the effect of different drying following preservation on the vitamins content in jute leaves.

2. Material and methods

2.1. Plant Sample

Fresh jute leaves of different varieties were harvested from 78 days old jute plant from the experimental plot was set in 2020 in Bangladesh Jute Research Institute field, Manik Mia Avenue, Dhaka-1207, Bangladesh. Healthy leaves were collected randomly from jute field. Three replications were used for each sample. Leaves were ground after drying and then preserved in freezer at -20˚C. Dry leaves were prepared in different years in oven (100˚C), in refrigerator (4˚C) and in open air in shade (±30˚C) in room temperature.

Leaves samples were prepared for vitamin B1, B2 and B3 estimation according to Okwu and Josiah [38] and photometric measurement were performed by spectrophotometer (UV-6300 PC, VWR, Radnor, PA).

Table 1 List of jute varieties that are used in the experiment

Species	Variety
Corchorus olitorius	O-9897
	JRO-524
	Robi-1
Corchorus capsularis	BJC-7370
	BJC-2197
	BJC-5003
	CVL-1
	Deshi pat shak-1

2.2. Chemicals

Ethanol, Sodium Hydroxide, Potassium Dichromate, Potassium Permanganate, Sodium Sulphate, Sulphuric acid, Ammonia solution and Potassium Cyanide. All the Chemicals are analytical reagent grade. For standard curve preparation Thiamine hydrochloride, Riboflavin and Nicotinic acid were purchased from local pharmaceutical shop.

2.3. Estimation of Thiamine (vitamin B1)

Fresh leaves 5.0 g were homogenized with ethanolic sodium hydroxide (50ml). In case of powder leaves 1g samples were taken. Ethanolic sodium hydroxide were prepared by dissolving 4.2 gm Sodium Hydroxide in 5 ml DH_2O and then 1L Ethanol (aldehyde free) were added in it. Allowing the solution to stand in tightly stoppered bottle for 24 hrs and then quickly decant the clear liquid in another suitable bottle.

Homogenized leaves samples were filtered into a100ml flask. And the colour was developed by addition of 10 ml of 0.1N Potassium Dichromate. Absorbance was measured at 360 nm.

2.4. Estimation of Riboflavin (Vitamin B2)

Leaves 5.0 g were chopped and treated with 100 ml of 50% ethanol solution. For powder leaves 1.0 g samples were taken. The samples were placed in a shaker for 1 hr. Then those were filtered into flask. Extracted samples of 10 ml were pipette and placed into the volumetric flask. Then Potassium Permanganate (5%) 10ml was added afterwards 10ml of 30% H_2O_2 were added and allowed to stand over a hot water bath for about 30min.Sodium Sulphate (40%) 2 ml was added. This was made up to 50 ml mark and absorbance was measured at 510 nm in spectrophotometer.

2.5. Estimation of Niacin (vitamin B3)

Fresh leaves were chopped and 5.0 g were taken and in case of preserved leaves powder, 1.0 g were taken for niacin estimation. The samples were treated with 50ml of 1 N H_2SO_4 and shaken for 30 min. Ammonia solution 3 drops were added to the sample and filtered. Filtrate 10ml was pipette into a 50 ml volumetric flask and 5 ml Potassium Cyanide (0.5g KCN dissolved in 100 ml cold DH_2O kept in refrigerator) was added. This was acidified with 5ml of 0.2 N H_2SO_4 and absorbance was measured at 470 nm wavelengths.

2.6. Standard preparation

Vitamin B1 standard stock solution of 100 ml was prepared by dissolving thiamine hydrochloride (43.4 mg) while vitamin B2 standard stock solution 100 ml were prepared by dissolving riboflavin (30.6 mg) in de-ionized water. Vitamin B3 or niacin standard stock 100 ml solution was prepared by nicotinic acid (53.9 mg) dissolved in the de-ionized H_2O. The working standard solution of each vitamin was prepared by taking 1ml of each solution and making final volume up to 50 ml with De-ionized water. Before injection, 0.2 mm syringe filter was used for filtration for all these solutions [39].

Thiamine hydrochloride (Vitamin 1), Riboflavin (Vitamin 2) and Nicotinic acid (Vitamin 3) standard curve are presented in Figure 1, Figure 2 and Figure 3, respectively.

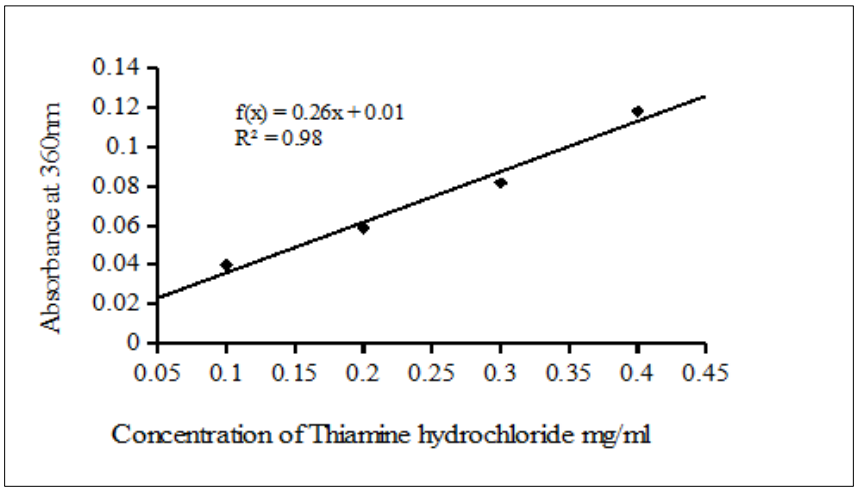

Figure 1 Calibration curve of Thiamine hydrochloride

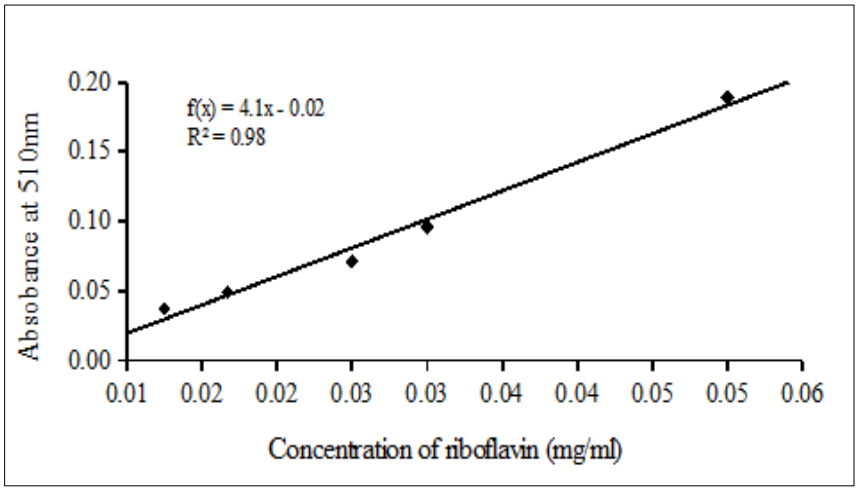

Figure 2 Calibration curve of riboflavin

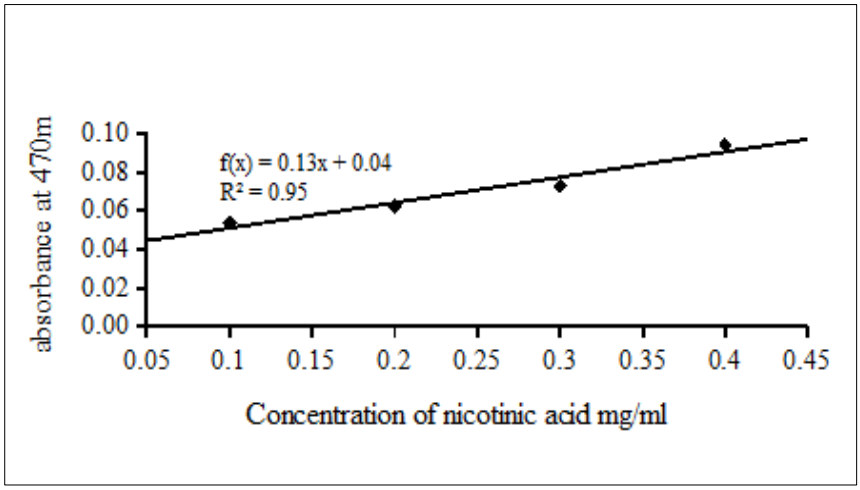

Figure 3 Calibration curve of nicotinic acid

3. Results

Thiamine, riboflavin and niacin content in fresh leaves of *Corchorus olitorius* and *Corchorus capsularis* are presented in Table 2. Among the olitorius varieties O-9897 shows higher content of thiamine 5.84 mg/g than the variety JRO-524 (3.32 mg/g) and Robi-1(3.22 mg/g). Variety Robi-1 and JRO-524 shows the almost similar amount of thiamine at 78 day old plant. Variety Robi-1 leaves at 47day old plant shows slightly higher content of thiamine 4.47 mg/g than the 78 day old plant. Among the capsularis varieties BJC-7370 shows higher amount thiamine 6.46 mg/g in comparison to other capsularis varieties. Leaves of BJC-2197, BJC-5003 and CVL-1 shows the almost similar content of thiamine 4.73, 4.40 and 4.26 mg/g respectively. Leaves of CVL-1 at the 20 days old plant shows comparatively higher 5.14 mg/g than the leaves from the 78 days old plant of CVL-1. Deshi pat shak-1 at the age of 81 days old plant shows comparatively very few amounts (0.11 mg/g) of thiamine than the leaves of all other varieties. There is no significant difference regarding thiamine content in jute leaves between two species as well as among the varieties within the species.

Table 2 Thiamine, riboflavin and niacin content in fresh jute leaves of different jute varieties

Species	Variety	Plant age (days)	Thiamine (mg/g)	Riboflavin (mg/g)	Niacin (mg/g)
C. olitorius	O-9897	78	5.84 ± 0.36	1.19 ± 0.04	14.14 ± 0.14
	JRO-524	78	3.32 ± 1.29	1.35 ± 0.13	12.01 ± 0.21
	Robi-1	78	3.22 ± 1.06	1.15 ± 0.02	14.00 ± 0.16
	Robi-1	47	4.47 ± 1.0	1.18 ± 0.01	18.77 ± 0.18
C. capsularis	BJC-7370	78	6.46 ± 1.12	1.17 ± 0.03	12.95 ± 0.10
	BJC-2197	78	4.73± 1.07	1.26 ± 0.02	13.82 ± 0.15
	BJC-5003	78	4.40± 0.24	1.30 ± 0.03	23.17 ± 0.19
	CVL-1	78	4.26 ± 1.09	1.20 ± 0.03	20.47 ± 0.21
	CVL-1	20	5.14 ± 1.13	1.18 ± 0.03	17.81 ± 0.36
	Deshi pat shak-1	81	0.11±0.017	0.99 ± 0.01	20.12 ± 0.42

Riboflavin in jute leaves in all the investigated varieties shows near about same amount ranged 1.15 to 1.35 mg/g except *deshi pat shak*-1. It contains below but nearly 1 (0.99) mg/g riboflavin. There is no difference of riboflavin content in the leaves of different varieties within two species.

Table 3 Thiamine, riboflavin and niacin content in preserved jute leaf powder of some *olitorius* and *capsularis* varieties

Species	Variety	Drying method	Preservation year	Vitamin B1 (mg/g)	Vitamin B2 (mg/g)	Vitamin B3 (mg/g)
C. olitorius	Robi-1	Cold dry	3	0.58 ± 0.01	11.10 ± 0.04	8.4 ± 0.27
	O-9897	Cold dry	5	0.41 ± 0.003	13.42 ± 0.55	13.4 ± 0.22
	O-9897	Oven dry	5	0.37 ± 0.002	4.24 ± 0.09	13.2 ± 0.14
	O-9897	Air dry	5	0.42 ± 0.003	13.40 ± 0.38	14.8 ± 0.57
	O-72	oven dry	5	0.42 ± 0.002	4.93 ± 0.15	13.5 ± 0.36
C. capsularis	CVL-1	Cold dry	3	0.58 ± 0.01	19.59 ± 0.61	5.8 ± 0.28
	CVL-1	Oven dry	5	0.53 ±0.004	9.14 ± 0.27	8.3 ± 0.11
	BJC-7370	Cold dry	3	0.57 ± 0.004	15.35 ± 0.05	6.5 ± 0.27
	BJC-2142	Cold dry	5	0.53 ± 0.003	11.62 ± 0.08	8.2 ± 0.12
	BJC-5003	Cold dry	5	0.54 ± 0.003	13.41 ± 0.05	7.4 ± 0.43
	BJC2197	Cold dry	5	0.36 ± 0.003	14.57 ± 0.05	6.7 ± 0.32

Niacin content was observed in higher amount in comparison to thiamine and riboflavin. Here in leaves of Robi -1 at 47 days old plant shows the higher amount 18.77 mg/g in comparison to the leaves of 78 days old plants. Leaves of 78 days old O-9897 and Robi-1 shows almost similar content 14.14 and 14.0 mg/g respectively but JRO-524 shows comparatively lower amount 12.01 mg/g than O-9897 and Robi-1 leaves at the 78 days plant. Leaves of BJC-5003 shows significantly higher amount 23.17mg/g of niacin than the other *capsularis* varieties. Leaves of the *capsularis* varieties BJC-7370 and BJC-2197 shows niacin content 12.95 and 13.82 mg/g respectively like the varieties of olitorius at 78 days old plants. Leaves of variety CVL-1 and *deshi pat shak*-1 showed higher niacin content 20.47 and 20.12 mg/g respectively in comparison to other varieties. Leaves of 20day old CVL-1 showed lower content of niacin 17.81 mg/g than the leaves of 78 day old CVL-1 plant.

Results of thiamine, riboflavin and niacin content in preserved jute leaf powder are presented in Table 3. Thiamine content was highest (0.58 mg/g) in cold dried olitorius variety Robi-1 and capsularis variety CVL-1 which were preserved for 3 years. Cold dried jute leaf powder of variety BJC-7370 shows nearly similar amount of thiamine 0.57 mg/g. Among the capsularis varieties preserved jute leaf of BJC-2197 shows lowest thiamine 0.36 mg/g. Leaf powder of oven dried O-9897 (preserved for 5years) shows lower amount of thiamine 0.37 mg/g. There is no effect of drying method (cold, oven and air drying) on thiamine content in preserved jute leaf powder.

Riboflavin in jute leaves were observed much higher in preserved leaves than the fresh leaves as mentioned in Table 2. Most of the variety shows above >11 mg/g riboflavin whereas the fresh one shows maximum 1.35 mg/g. Highest content of riboflavin (19.59 mg/g) was found in cold dried leaf powder of CVL-1 preserved for 3 years. Then the second highest riboflavin content 15.35 mg/g was observed in cold dried BJC-7370 which was preserved for 3 years. Cold dried Robi-1, O-9897, air dried O-9897 of olitorius varieties and BJC-2142, BJC-5003 and BJC-2197 of capsularis varieties shows riboflavin range 11.10 to 14.57 mg/g. Oven dried O-9897 and oven dried CVL-1 shows lower riboflavin 4.24 and 9.14 mg/g respectively, both were preserved for 5years. In this regard there was no effect of drying method found in riboflavin content in jute leaf powder.

Preserved jute leaf powder contain good amount of niacin. Air dried O-9897 sample shows the highest 14.8 mg/g among all the tested samples. The second highest niacin content was observed in oven dried O-72 leaves (13.5 mg/g), cold dried O-9897 leaves (13.4 mg/g) and Oven dried O-9897 leaves (13.2 mg/g). In *capsularis* varieties preserved leaves shows comparatively lesser amount of niacin than leaves of *olitorius* which ranged from 5.8 to 8.2 mg/g. whereas preserved *olitorius* leaves shows niacin content ranged 8.4 to 14.8 mg/g. drying methods have no effect on niacin content in preserved jute leaf powder also.

4. Discussion

Leaves of different varieties of two cultivated species *Corchorus olitorius* and *Corchorus capsularis* shows good amount of thiamine (Table-2). Varieties *Corchorus olitorius* have thiamine > 3 to 6 mg/g and varieties of *Corchorus capsularis* contain >4 -6 mg/g. Thiamine content in jute leaves was mentioned 0.1 mg/100g in food composition table made by Shaheen and her Colleague [13]. In another report Adeniyi and his Colleague [37] found 0.04 mg/100g dw. in *C. olitorius*. Sarwar and her Colleague [11] investigated vitamin B1in different vegetables but did not find it in jute leaves.

Riboflavin was found in leaves of different varieties of two cultivated jute species. Varieties of both species showed almost similar amount of riboflavin (> 1 mg/g) (Table-2). Shaheen and her Colleague [13] mentioned in food composition table 0.55 mg/100g riboflavin present in jute leaves. Adeniyi and his Colleague [37] found riboflavin 0.06mg/100 g dw. in *C. olitorius*. Sarwar and her Colleague [11] reported 0.35 mg/100g vitamin B2 in jute leaves.

Niacin was found very high amount in leaves of different varieties of two cultivated jute species. In this study niacin was found 12 -19 mg/g in *Corchorus olitorius* and 12.95 – 23.17mg/g in *C. capsularis*. Shaheen and her Colleague [13] reported 1.6 mg/100g niacin in jute leaves in food composition table. Adeniyi and his Colleague [37] found 0.61 mg/100g dw. niacin in *C. olitorius*. Sarwar and her Colleague [11] did not find vitamin B3 in jute leaves in their investigation.

Thiamine content was observed in preserved jute leaves powder. In comparison to the report of fresh jute leaves, preserved jute leaves powder showed lower content of thiamine (Table - 2). Thiamine is unstable to heat [40] and destroyed by oxygen in the air and water [30]. According to the previous findings, drying significantly reduces the thiamine content in *Spinacia oleracea* but significantly increases thiamine content in *Tamarindus indica* [41]. This present result shows the similarity with report of *Spinacia oleracea* as both belong to the category green leafy vegetables. Thiamine in bulgur (whole wheat product) was higher in open air sun drying than in hot air oven drying at 60, 70 and 80˚C [42]. So heat may have effect on reduction in thiamine content in jute leaves.

Riboflavin content was much higher in preserved jute leaf powder (Table - 3) in comparison to fresh jute leaves. Preserved jute leaf powder of different varieties of both species showed high amount of riboflavin. Riboflavin is relatively heat stable [43]. Dry fruits are considered as rich source of riboflavin. Almond and cashew nut, classified under dry fruits, had highest riboflavin and thiamine respectively [44]. Drying may assist for more availability of riboflavin. Therefore, more riboflavin was obtained in jute leaves powder by different method of drying.

This study finds that niacin content was not destroyed much in preserved powder jute leaves. According to much of the literature, niacin is a quite stable vitamin [45, 46]. Niacin is known to be very stable vitamin being resistant to destruction by heat, light, acid, alkali and oxidation [47]. Present reports of niacin content in jute leaves are found stable through drying, which are in agreement with the previous report.

5. Conclusion

Jute leaves contain thiamin, riboflavin and niacin. There is no major difference in the leaves of different varieties of two species regarding thiamin, riboflavin and niacin content. Drying have effect on thiamin content in jute leaves, reduction occurs through different drying process. Good amount of riboflavin was found in dry jute leaves in comparison to the fresh jute leaves. Niacin was found retained in dry jute leaves and not destroyed much. Both fresh and preserved jute leaves may serve the requirement of thiamine, riboflavin and niacin.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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